L. C. Foster
0/074 B-68

INSTRUCTIONS

For "ALNOR" DEW POINTERS

INDEX

	Page Numbers
Introduction	1
Operation	
Principle	5
Connections	1
Adjustment	1
Operation	1
As a Go-No-Go Gage	11
Operating Notes	6
Calculator	4
Q Value	
Definition	5
Common Gases	2
Heat Treating Mixtures	
Types	3
Trade Name	4
Computation	8
K to Q Conversion	After Page 8
Required Accuracy	10
Vapor Density	10
Vapor Pressure	10
Elevated Pressure Dew Point Measuring	11
Psychrometric Charts	11

FIGURES

Number	Title	After Page Number.
1	Schematic Diagram	1
2	Alnor Dew Pointer	1
3	K to Q Conversion Curve	8
4	Q Value of Gas Mixtures	9
5	Effect of Q Value on Dew Point Indicator	On 10
6	Vapor Pressure & Vapor Density Curve	
7	(-100 to 30°F)	10
	(-30 to 110°F)	10
8	Dew Point Conversion Chart (for elevated pressures)	11
9	Psychrometric Chart (1 to 14% R. H.)	11
10	Psychrometric Chart (Standard)	11

TABLES

Number	Title	Page Numbers
1	Q Values of Common Gases	2
	Q Values for Gas Mixtures used in heat treating	
2	(by types)	3
3	(by trade names)	4
4	Gas Constants	9
5	Temperature Conversion	12

Copyright 1947 Illinois Testing Laboratories, Inc.

Form No. 7240

PRINTED IN U.S.A.

IM 7/62

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_05269

INSTRUCTIONS FOR "ALNOR" TYPE 7000 DEW POINTERS

Introduction

The Alnor Dew Pointer is used to determine the dew point of a gas-water vapor mixture. When a gas-water vapor mixture is cooled there is some temperature at which water will begin to condense out. By definition this temperature is known as "Dew Point".

As a sample of a gas-water vapor mixture is cooled its relative humidity is increased. If the sample is cooled sufficiently the relative humidity will reach 100% — i.e. the sample will be "saturated". Any further cooling will result in the precipitation of water. Therefore the saturation temperature and the dew point temperature are identical values.

Dew Point is a convenient way of determining and expressing the absolute humidity of air and other gases.

The 7000 instrument is available in three nominal dew point ranges as follows:

TYPE	NOMINAL DEW POINT RANGE
7000H	Room Temp. to - 20°F.
7000U	Room Temp. to - 80°F.
7000L	0°F. to - 80°F.

The actual range of each instrument is dependent on the temperature of the Dew Pointer and the gas being tested in addition to the range of the pressure ratio gauge.

The convenience, portability, accuracy, reproducability (several different operators can easily get the same results) and freedom from the use of external coolant, make the instrument highly desireable.

Connections

On A.C. models connect the Dew Pointer to a convenient 50 or 60 cycle A.C. source of the voltage indicated on the instrument name plate, by means of the cable provided.

Connect the source of gas to the inlet (bottom center) of the meter. Copper connecting tubing is most desireable (sweat the copper tubing to the fitting supplied), although a dense neoprene tubing may be used for dew points above -20 F. Ordinary rubber tubing may cause large errors. **All Connections Must Be Tight.**

If the source of gas is at a pressure appreciably above atmospheric pressure a shut off valve should be provided in the inlet line.

The outlet of the Dew Pointer (rear) may be connected to a suitable waste line if desired.

Adjustments

Before operating the Dew Pointer, a Unity Adjustment must be made on the Pressure Ratio Gauge as follows:

1. Place operating valve in out position.
2. Open Purging Valve to be sure there is no pressure in the instrument.
3. Depress the Gauge Valve and turn the Unity Adjuster until the bottom of the meniscus is in line with the 1 mark.
4. Release the Gauge Valve.

Close the purging valve and pump up the instrument until the pressure ratio gauge reads about .5. Open the purging valve. If the meniscus does not return to the 1 mark after a few moments, repeat the unity adjustment as above. It sometimes happens that after a period of prolonged idleness the flexible diaphragm in the oil reservoir takes a set, but the above operation will correct the condition.

If the source of gas is above atmospheric pressure be sure to shut off the source of pressure before making the unity adjustment.

WARNING: Never depress the gauge valve unless the operating valve is out and the purging valve open, and the supply valve closed.

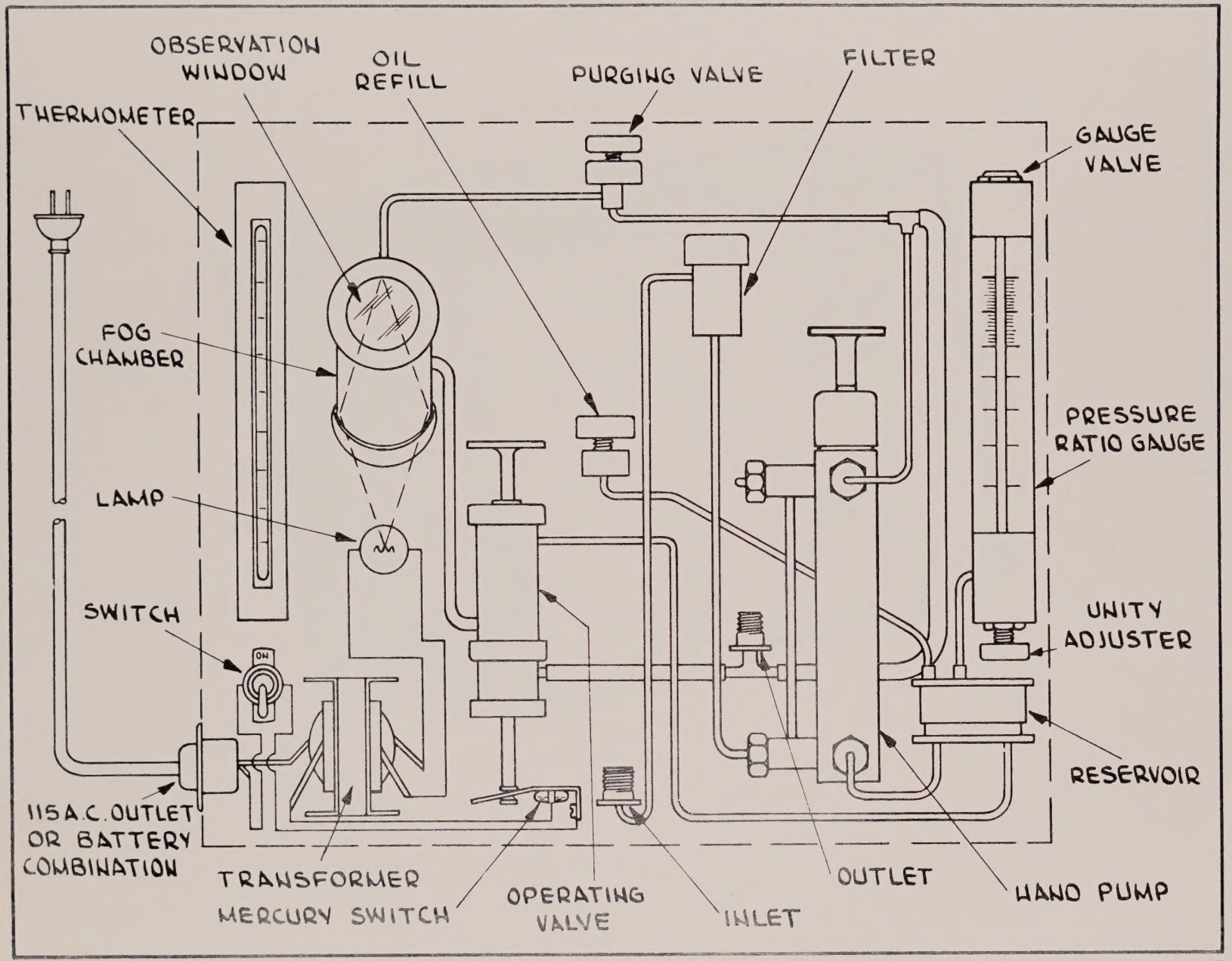
The unity adjustment should be checked frequently-particularly if the instrument temperature or barometer pressure is fluctuating.

Operation

Open the purging valve. Pull out the operating valve. Turn the switch to "ON". On combination A. C. and Battery instruments place switch in the "A. C." or "B" position according to the power source that is to be used.

Pump the gas to be tested thru the instrument to flush out all the old gas in the Dew Pointer (at least 10 to 15 strokes of the pump). When very low dew points are to be tested more thorough purging is required. The Dew Pointer will give the correct dew point of the sample in the instrument. Be sure to flow enough gas thru so that the gas in the instrument is the gas you want to test.

When the gas is generated under pressure, permit this pressure to force the gas



SCHEMATIC DIAGRAM

FIG. 1

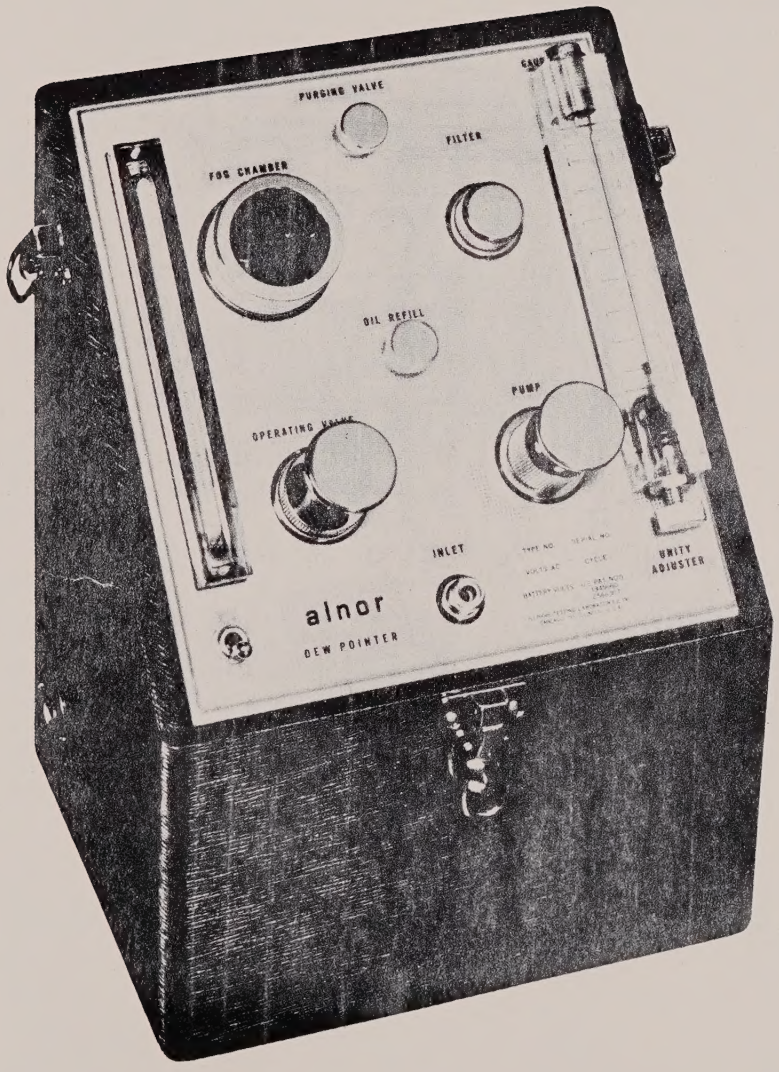

PURGING VALVE
FILTER
FOG CHAMBER
OIL REFILL
PUMP
INLET
UNITY ADJUSTER
alnor
DEW POINTER

FIG. 2

thru the instrument to perform the purging operation, and minimize the pumping.

Close the purging valve. Pump a sample of gas in the instrument. Look into the observation window and press down on the operating valve.

Depressing the operating valve actually performs three operations in the following sequence.

1. Closes line from the inlet and pressure ratio gauge.
2. Turns on the light.
3. Rapidly opens the line from fog chamber to the atmosphere.

If a fog (cone of sunbeams) appears, it indicates the gas was cooled below the dew point and subsequent trials should be made at lower pressures (numerically higher pressure ratios). Make similar trials at each higher major division on the pressure ratio gauge until one reading is obtained where no fog appears. Then "Close In" on the end point, i.e. maximum pressure ratio that will produce a fog.

The object of the operation of the Dew Pointer is to determine the pressure ratio that will just produce a fog. This is called the "End Point".

If on the first trial no fog appears, it indicates that the gas was not cooled down to the dew point. It is apparent, therefore, that a lower pressure ratio (higher pressure) is required to produce sufficient cooling to reach the dew point. Subsequent trials should, therefore, be made at each lower (higher pressure) major division on the Pressure Ratio Gauge until one trial is obtained in which a fog appears. Having located one point where there is a fog and one where there is no fog, "close in" on the end point. It is easily possible to get the difference between the appearance and non-appearance of the fog to be only .01 apart, as read on the pressure ratio gauge.

After any trial in which a fog appears, it is advisable to take several strokes on the pump to purge the fog chamber of any droplets of moisture that fail to re-evaporate promptly.

When making the last trials near end point, permit 10 to 15 seconds to lapse after pumping the sample into the instrument before pushing down the operating valve to permit the sample to come to the temperature of the fog chamber.

The experienced operator will find he can determine the end point after a few trials since the density of the fog on any given trial is a valuable clue to how far he is from the end point.

If the approximate value of the dew point is known, the reverse operation of the Dew Point Calculator will indicate the approximate Pressure Ratio which should be used for the initial trial. This will further reduce the number of trials required to achieve the end point.

After determining the end point, take the mean between the minimum pressure ratio that fails to produce a fog and the maximum pressure ratio that produces a fog. Use this value with the initial temperature as read on the thermometer and the Q value for the gas being tested to compute the dew point with the "Alnor" Dew Point Calculator.

Q Values

The Q value of a gas is a natural constant of the gas. It is representative of the cooling power of the gas.

The Q value of the gas being tested must be known to arrive at the dew point of the gas. Values of common gases are given below.

TABLE 1

		Q
Air		.2855
Carbon Dioxide	CO_2	.225
Carbon Monoxide	CO	.2855
Hydrogen	H_2	.2855
Methane	CH_4	.240
Nitrogen	N_2	.2855
Oxygen	O_2	.2855
Argon	A	.400
Helium	He	.400
Other Gases	Refer to chemical Handbooks	
Gas Mixtures	Refer to Tables 2 and 3, and the Appendix.	

TABLE 2

Q VALUES FOR COMMON GAS MIXTURES USED IN CONTROLLED ATMOSPHERE HEAT TREATING

Type 1 EXOTHERMIC BASE

Prepared by combustion of gas and air followed by dehydration

Type 1a LEAN MIXTURE: (Air-Gas Ratio 9:1) Q .278

Typical Analysis in % by volume
87% N_2; 1.5% CO; 10.5% CO_2; 1% H_2;

Type 1b RICH MIXTURE: (Air-Gas Ratio 6:1) Q .281

Typical Analysis in % by volume
71.5% N_2; 10.5% CO; 5% CO_2; 12.5% H_2; .5% CH_4

EXOTHERMIC BASE

Above followed by passage thru incandescent charcoal bed.

Type 1c LEAN MIXTURE: (Air-Gas Ratio 9:1) Q .2855

Typical Analysis
78% N_2; 20% CO; 2% H_2

Type 1d RICH MIXTURE: (Air-Gas Ratio 6:1) Q .2855

Typical Analysis
67% N_2; 19% CO; 13.5% H_2; .5% CH_4

Type 2 PREPARED NITROGEN BASE

Prepared by the cumbustion of gas and air followed by the removal of the CO_2 and water vapor.

Type 2a LEAN MIXTURE: (Air-Gas Ratio 9:1) Q .2855

Typical Analysis
97% N_2; 2% CO; 1% H_2

Type 2b RICH MIXTURE: (Air-Gas Ratio 6:1) Q .2855

Typical Analysis
75% N_2; 11% CO; 13.5% H_2; .5% CH_4

Type 3 ENDOTHERMIC BASE

Gas-Air mixture reacted in externally heated catalyst filled chamber.

Type 3a PARTIALLY REACTED Q .2845

Typical Analysis
45% N_2; 20% CO; .5% CO_2; 34% H_2; .5% CH_4

Type 3b COMPLETELY REACTED Q .2845

Typical Analysis
40% N_2; 21% CO; 38% H_2; 1% CH_4

Type 4 CHARCOAL BASE Q .2855

Air passed thru externally heated charcoal filled chamber
Typical Analysis
64% N_2; 35% CO; 1% H_2

Type 5 AMMONIA BASE Q .2855

Ammonia dissociated in externally heated chamber.
Typical Analysis
25% N_2; 75% H_2

Type numbers are shown only to provide a cross reference between Table 2 and Table 3.

Following Tabulations from data available on some of the popular gas generators. Although the list is not complete, the data will be helpful in many instances.

TABLE 3

GENERATOR-MANUFACTURER	TYPE GAS DESIGNATION		Q
American Gas Furnace Co.	5		.286
Associated Industrial Engineers	1a	Lean Exogen	.278
	1b	Rich Exogen	.281
	2	Monogan	.2855
	3	Endogen	.2845
	5	Amogen	.2855
Lindberg Engineering Co.	1a	Lean Hyex	.278
	1b	Rich Hyex	.281
	3	Hyen	.285
	4	Hyco	.285
	5	Hyam	.285
Mahr Mfg. Co.	2a	Prepared N_2	.285
	2b	No-ox	.285
Surface Combustion	1a	Lean DX	.278
	1b	Rich DX	.281
	2	NX	.285
	3	RX	.285
	4	Char-Mo	.285
	5	AX	.285
Whse. Electric Corp.	1a	Lean Exogas	.278
	1b	Rich Exogas	.281
	2	Monogas	.285
	3	Endogas	.285
	5	Amogas	.285
Electric Furnace Co.	1a	Cumbustion Type for non-ferrous Metals	.278
	1b	Standard Combustion Type	.281
	3	Endothermic Type	.285
General Electric Co.	1a	Lean Atmosphere Gas Converter	.278
	1b	Rich Atmosphere Gas Converter	.281
	1c	Drycolene	.285
	1c	Neutralene	.285
Hevi Duty Electric Co.	3	Cracked	.285

Use Of The Dew Point Calculator

To use the Dew Point Calculator the following values must be known

1. Q value of the gas.
2. The initial temperature of the gas as read on the thermometer on the Dew Pointer.
3. The pressure ratio required to just produce a fog.

If the Q value is .2855 proceed as follows:

1. Set the arrow "2" opposite the pressure ratio on scale "D".

2. Opposite the initial temperature on scale "F" read the Dewpoint temperature on scale "E".

NOTE: All temperatures are in degrees Fahrenheit.

EXAMPLE: Air is being tested so the Q value is .2855. The thermometer reads 75° F. A fog appears at a pressure ratio of .46, but does not appear at .47, therefore, the end point is .465.

1. Set the arrow "2" opposite .465 on scale "D".
2. Opposite 75 in scale "F", read the dewpoint temperature of -29.5° F. on the scale "E".

If the Q value is not .2855 proceed as follows:

1. Set the arrow "1" opposite the pressure ratio on Scale "A".
2. Opposite the Q value (Scale "C") read the "Equivalent Pressure Ratio" on Scale "B".
3. Set the arrow "2" opposite the "Equivalent Pressure Ratio" on Scale "D".
4. Opposite the initial temperature (Scale "F") read the dewpoint temperature on Scale "E".

EXAMPLE: Pure methane is being tested. The Q value is .24. The initial temperature is 80° F. A fog appears at .51 but does not appear at .52 so the end point is .515.

1. Set the arrow "1" opposite .515 (Scale "A").
2. Opposite .24 (Scale "C") read the equivalent pressure ratio of .57 on Scale "B".
3. Set the arrow "2" opposite .57 on Scale "D".
4. Opposite 80° F. on Scale "F" read the dewpoint of 0° F. on Scale "E".

Principle Of Operation

The principle of operation of the Dew Pointer is fundamental and simple. A thorough understanding of this principle will aid in the operation of the instrument.

The gas to be tested is pumped into the observation chamber at some pressure above atmospheric. The chamber is then rapidly exhausted to the atmosphere with a resultant expansion and cooling of the gas. If the cooling is sufficient to reduce the temperature of the gas to, or below, the dew point, water vapor will condense out in the form of a fine mist or fog. This fog is readily observable thru the observation window. Because of a light located below the fog chamber focused at the top of the chamber, the fog appears as a cone of sunbeams.

Successive trials will determine the minimum initial pressure which will produce a fog. The gas is then being cooled just to the dew point. The final temperature after expansion (the dew point) which is maintained for too brief an interval to measure, is then computed by means of the equation for an adiabatic expansion. The expansion is adiabatic (no heat added or subtracted during the process) because it is so rapid.

The following equation expresses a fundamental relationship between the pressure and temperature during an adiabatic expansion.

$$\text{Final Temp.} = \text{Initial Temp.} \left[\frac{\text{Final Pressure}}{\text{Initial Pressure}}\right]^{\frac{K-1}{K}}$$

where all values are in absolute units and

$$K = \frac{\text{specific heat at constant pressure}}{\text{specific heat at constant volume}}$$

For the "Alnor" Dew Pointer, the final temperature is the dew point temperature ($t_{D.P.}$). The ratio (P.R.) between the final pressure and initial pressure can be read directly on the pressure ratio gauge without necessity of knowing the individual quantities. By definition $Q = \frac{K-1}{K}$

The equation for an adiabatic expansion can, therefore, be converted into the following form for our purpose

$$t_{D.P.} = (t_i + 460)\,(P.R.)^{Q} - 460$$

when the temperatures are in ^{o} F.

Since the initial temperature (t_i) is read on the thermometer, P. R. is read on the pressure ratio gauge, and Q is a constant that depends on the gas being tested, it is apparent that the solution for the dew point temperature ($t_{D.P.}$) is perfectly straightforward though somewhat cumbersome. In actual use, a calculator is supplied that makes the above computation extremely simple.

The formation of a visible fog at the dew point temperature depends on the presence of dust in the gas to act as nuclei around which the droplets can form. In practically all cases dust is present. If, however, gas is completely dust free (such as gas produced by fractional distillation) it would be possible to cool the gas below the dewpoint temperature without condensing the moisture, if some substitute for the dust particles were not provided. All ALNOR Dew Pointers are therefore equipped with a strip of radium foil built into the fog chamber. The Radium ionizes the gas in the chamber and the ions act as nuclei around which the droplets can form and build up to visible size. These Dew Pointers will, therefore, give the correct result regardless of the presence or absence of dust.

Operating Notes

When working with dry gases having low dew points, it should be remembered that extremely small quantities of water vapor are involved. It should further be remembered that the instrument can only give the result for the gas sample that is actually in the fog chamber. It is for this reason that it is extremely important that the gas does not pick up or lose moisture in the process of being transferred from its source to the fog chamber.

Copper tubing is the most satisfactory material for connecting the instrument to the source of gas because it is not hygroscopic. The use of rubber tubing will almost certainly contaminate the gas sample. A dense neoprene tubing is satisfactory except for very dry gases.

It is for the same reason that the filter material should be replaced occasionally. If an appreciable quantity of dust is allowed to accumulate in the filter, the moisture content of the gas may be altered as it passes through the filter.

The built in hand pump is double acting. The gas flowing on the top side of the piston is discharged through the outlet without flowing through the fog chamber.

The only function of this gas is to keep the pump barrel dry and avoid contamination of the test gas.

Thorough initial purging of the instrument is important. Reference to the vapor density curves (figs. 7 & 8) show that the vapor density at 50° F. is .59 lbs. per 1000 cu. ft. and the vapor density at -70° F. is only .0019 lbs. per 1000 cu. ft. If the instrument were originally filled with air having a dew point of 50° F. and only .1% of the original volume were left in the chamber due to inadequate purging the instrument would give an indication that was 3° high when testing a sample of gas having a dew point of -70°F.

It is, of course, important to have all connections tight on the inlet side of the instrument. In some cases momentary negative pressures can be caused in the inlet line by the operation of the hand pump. If there were a leak in the inlet line atmospheric air could flow in and add moisture to the sample during these short periods of negative pressure. Furthermore, the vapor pressure of the air is generally higher than the vapor pressure of the gas being tested. It is, therefore, possible for water vapor to flow in through a leaky connection even when the gas pressure is above atmospheric.

If the gas is drawn from a high pressure, as from a bottle of compressed gas, a pressure reading valve or a needle valve will be needed ahead of the Dew Pointer. A connecting line of adequate size is needed (¼" copper tubing is suggested). Do not use capillary tubing. Do not use an extremely high rate of flow during purging. The use of an excessive flow rate or the use of capillary tubing may cause moisture to be removed from the gas before it enters the Dew Pointer.

The above caution does not infer that the flow rate during purging is extremely critical. If the flow rate is such that the oil in the pressure ratio gauge is between .99 and .95 it will be quite satisfactory.

The flow rate must, of course, be great enough to back up the hand pump. The pumping action should not pull an appreciable vacuum on the inlet line.

Notice that there is a by-pass around the fog chamber thru the top side of the pump. If there is pressure on the inlet side of the Dew Pointer it is quite normal to have a continuous flow from the instrument.

If a hazardous or noxious gas is being used it is permissible to connect a discharge line to the outlet of the Dew Pointer. It should be of ample size so that the pressure at the outlet is essentially atmospheric. Do not use a gas that will attack brass or copper.

APPENDIX

Q Value Of Mixtures

A mixture of gases can be treated as a single gas if the proper constants are established. The value of Q can be computed by one of the following methods.

METHOD 1 - MASS BASIS

Since the effect that the specific heat of an individual gas has on the specific heat of the mixture is proportional to the mass of the gas present the following equation can be written.

$$(1)\ C_{pm}=\frac{M_x}{M_m}C_{px}+\frac{M_y}{M_m}C_{py}+\text{----}+\frac{M_z}{M_m}C_{pz}$$

$$(2)\ C_{vm}=\frac{M_x}{M_m}C_{vx}+\frac{M_y}{M_m}C_{vy}+\text{----}+\frac{M_z}{M_m}C_{vz}$$

Where

C_{pm} = Specific heat at constant pressure of the mixtures

C_{vm} = specific heat at constant volume of the mixture

C_{vx}, C_{vy}, & C_{vz} = specific heat at constant volume of each gas.

C_{px}, C_{py}, & C_{pz} = specific heat at constant pressure of each gas.

M_m = total weight of the mixture

M_x, M_y & M_z = weight of each gas

Specific heats are expressed in heat units per weight unit per temperature unit such as B.T.U. per pound per ^{o} F.

Then

$$(3)\ K_m=\frac{C_{pm}}{C_{vm}}$$

and

$$(4)\ Q_m=\frac{K_m-1}{K_m}$$ or from figure 3

where

K_m = K value for the mixture

Q_m = Q value for the mixture

It is only necessary to insert the proper values in equations (1) and (2) and then solve.

EXAMPLE FOR METHOD 1

A mixture of gas is known to be composed of the following:

20% by weight CH_4
40% by weight CO_2
40% by weight N_2

Find the value of Q

Substituting in equations 1 and 2

C_{pm}=.2 (.593)+.4 (.200)+.4 (.247)=.2974

C_{vm}= .2 (.450)+.4 (.155)+.4 (.176)=.2244

Then

$$K_m=\frac{.2974}{.2224}=1.337$$

and

$$Q_m=\frac{.337}{1.337}=.252$$

METHOD 2 - VOLUMETRIC BASIS

When a mixture of gases is analyzed with an Orsat apparatus the percentages of each component are determined on a volumetric basis. It is, therefore, essential that these volumetric percentages be converted to weight percentages before Method 1 can be used.

$$(5)\ \frac{M_x}{M_m}=\frac{Xd_x}{d_m}\qquad \frac{M_y}{M_m}=\frac{Yd_y}{d_m};\ \text{etc.}$$

where

X = percent by volume of gas X

d_x = density of gas X

d_m = density of the mixture

Notice that any condition of temperature and pressure and any units of density can be used provided the same conditions and units are used thruout.

Equations 1, 2, 3, & 5 can be combined and multiplied by $\frac{d_m}{d_m}$ to following simple form.

$$(6)\ K_m=\frac{Xd_xC_{px}+Yd_yC_{py}+\text{---}+Zd_zC_{pz}}{Xd_xC_{vx}+Yd_yC_{vy}+\text{---}+Zd_zC_{vz}}$$

Where X, Y and Z are volumetric percentages of each gas and d_x, d_y, and d_z are the density of each gas.

Since the values of d_xC_{px} are presented in Table 4 the solution of Equation 6 is extremely simple. Q can be obtained from Figure 3. Because of similarity of values CO, O_2, H_2, and N_2, can be considered one gas.

K TO Q CONVERSION CURVE

FIG. 3

ALNOR INSTRUMENT COMPANY
Division of
Illinois Testing Laboratories, Inc.
420 NORTH LA SALLE STREET
CHICAGO 10, ILLINOIS

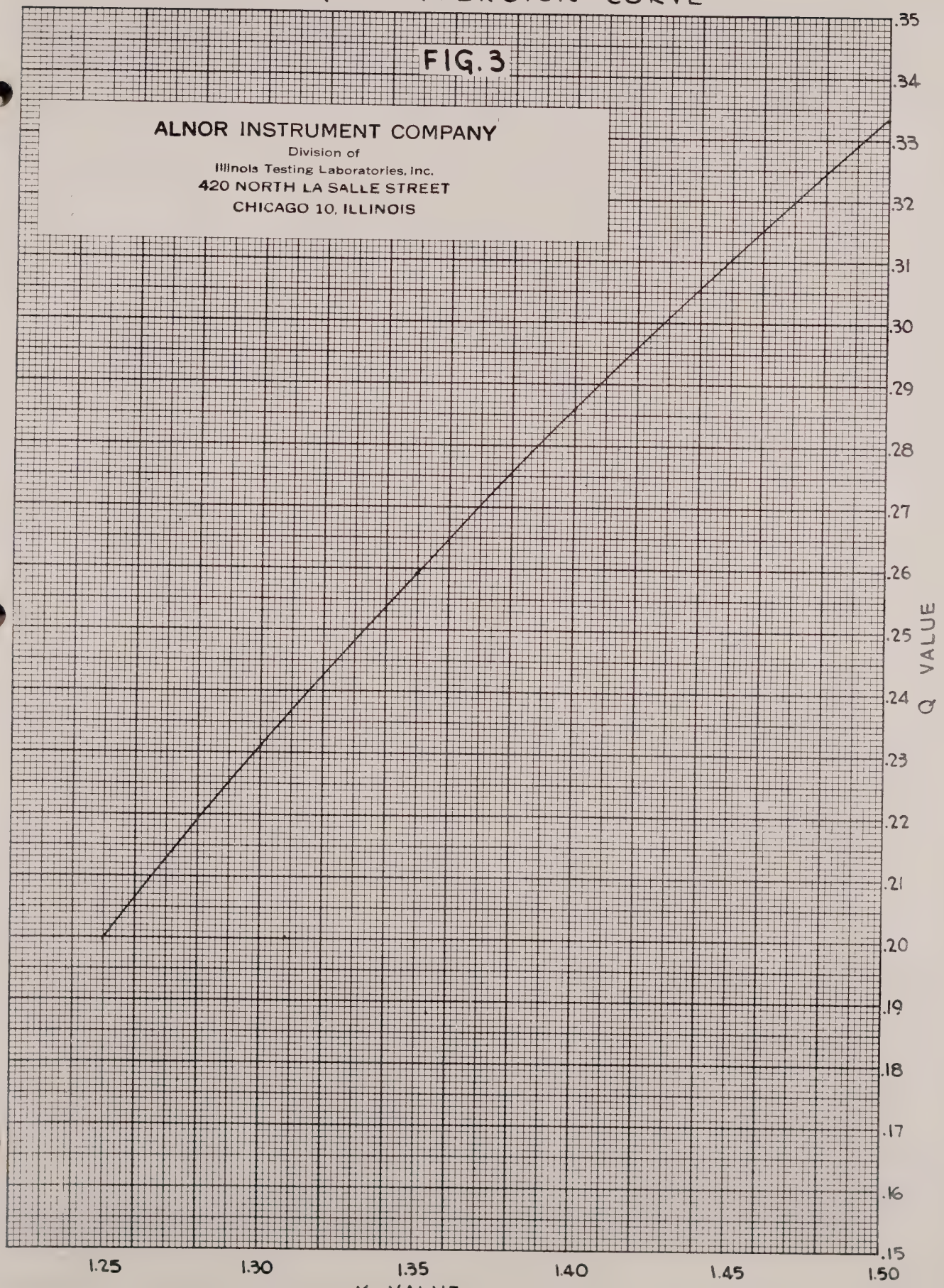


TABLE 4

Gas	Density lbs/ c.f. @62° F.	C_p B.T.U. per lb.	C_v B.T.U. per lb.	$(d)C_p$ B.T.U. per c.f.	$(d)C_v$ B.T.U. per c.f.	K	Q
CO	.0735	.245	.175	.0180	.0128	1.40	.2855
N_2	.0737	.247	.176	.0182	.0130	1.40	.2855
O_2	.0840	.217	.155	.0182	.0130	1.40	.2855
Air	.0757	.241	.171	.0182	.0130	1.40	.2855
H_2	.00529	3.42	2.44	.0181	.0129	1.40	.2855
CO_2	.1156	.200	.155	.0231	.0179	1.29	.225
CH_4	.0421	.593	.450	.0250	.0190	1.315	.240
He	.01114	1.25	.7530	.0139	.0084	1.660	.400
A	.11135	.125	.0751	.0139	.0084	1.668	.400

Notice that all diatomic gases listed can be treated as a single gas for all practical purposes.

EXAMPLE FOR METHOD 2

A mixture of gases is known to consist of the following:

72% by volume N_2

12.5% by volume of H_2

10% by volume of CO

5% by volume of CO_2

.5% by volume CH_4

Find the value of Q

Substituting in equation 6

Gas	Numerator	Denominator
N_2	.72 (.0182) = .01310	.72 (.0130) = .00936
CO	.10 (.0180) = .00180	.10 (.0128) = .00128
CO_2	.05 (.0231) = .00116	.05 (.0179) = .00090
H_2	.125 (.0181) = .00226	.125 (.0129) = .00161
CH_4	.005 (.0250) = .00013	.005 (.0190) = .00010
	.01845	.01325

$$K_m = \frac{.01843}{.01325} = 1.392 \quad Q_m = .281$$

METHOD 3 - CURVES

A great many commonly used mixtures primarily consist of only one gas other than diatomic gases. For these mixtures values of Q can be picked off of the curves in Figure 4.

The curves in Figure 4 are plotted for mixtures which consist of percentages of the gas named where the balance of the mixture is N_2, O_2, H_2 or CO. If small percentages of other gases are present, they can be ignored.

EXAMPLE - METHOD 3

Given the mixture specified for the example of Method 2 find the value of Q by use of Figure 4.

Since the values of d (C_p) and d (C_v) are so nearly equal for all the diatomic gases assume that they are actually one gas having the characteristics of N_2. Since the volume of CH_4 is small add it to the CO_2 for this purpose, then the analysis of the gas becomes

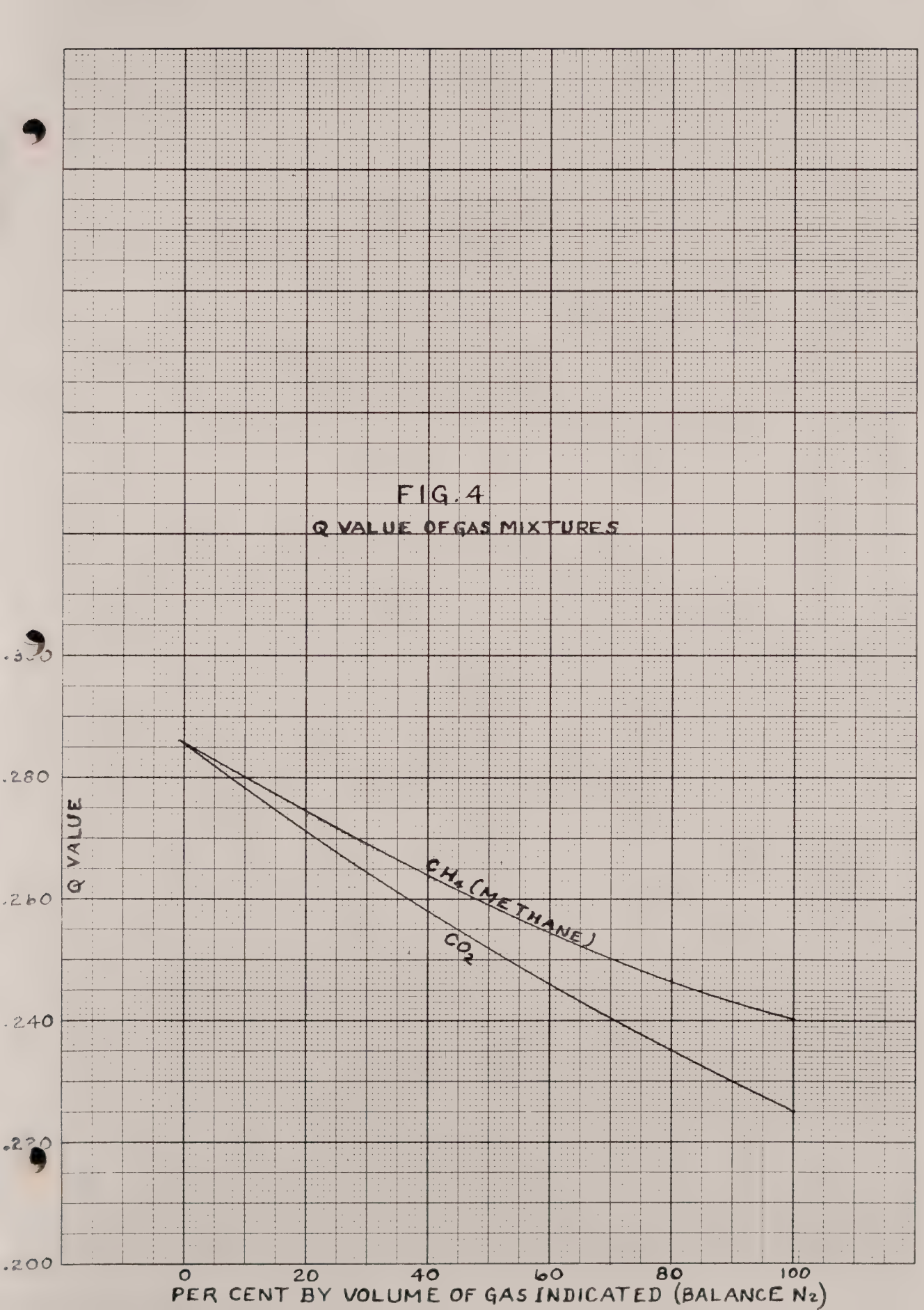
5.5% by volume CO_2

94.5% by volume N_2

From Figure 4 Q = .281

FIG. 4

Q VALUE OF GAS MIXTURES



ACCURACY OF GAS ANALYSIS

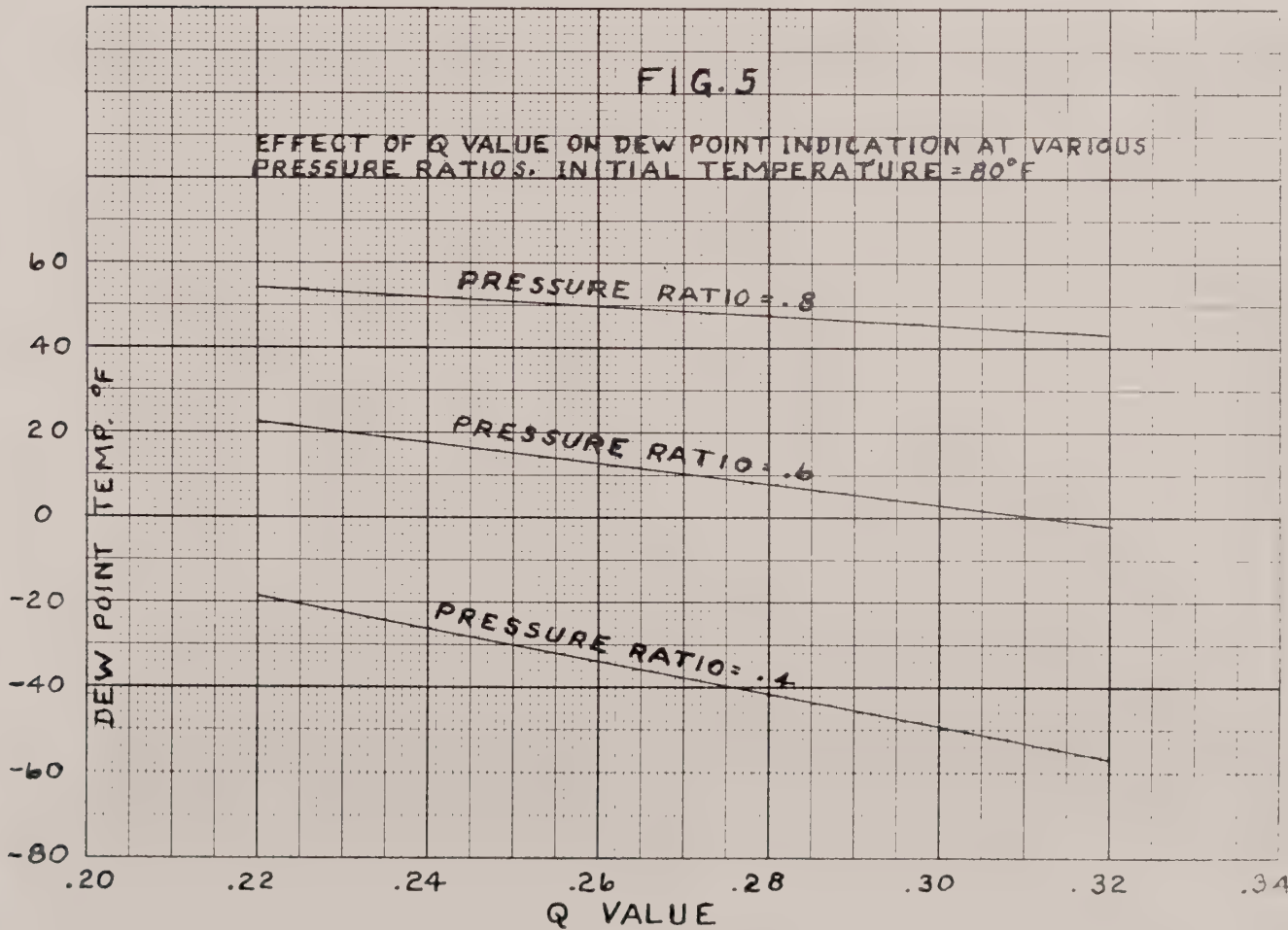
An error of .005 in the Q value will produce an error of approximately 2° F. when the pressure ratio is .4; the error will be less for higher pressure ratios. It is, therefore, apparent an error of about 10% in the volumetric analysis of CH_4 or about 7% in the volumetric analysis of CO_2 is generally permissible. It is, therefore, evident that the "Alnor" Dew Pointer is not dependent upon an accurate gas analysis as far as common mixtures are concerned. It is obviously not necessary to make an Orsat analysis prior to each dew point test.

Figure 5 graphically shows the effect of Q value in the dew point determination assuming an initial temperature of 80° F. For comparatively high dew points (above 0° F.) this value is far from critical. For lower dew points the value of Q should be known with greater accuracy.

VAPOR DENSITY AND VAPOR PRESSURE

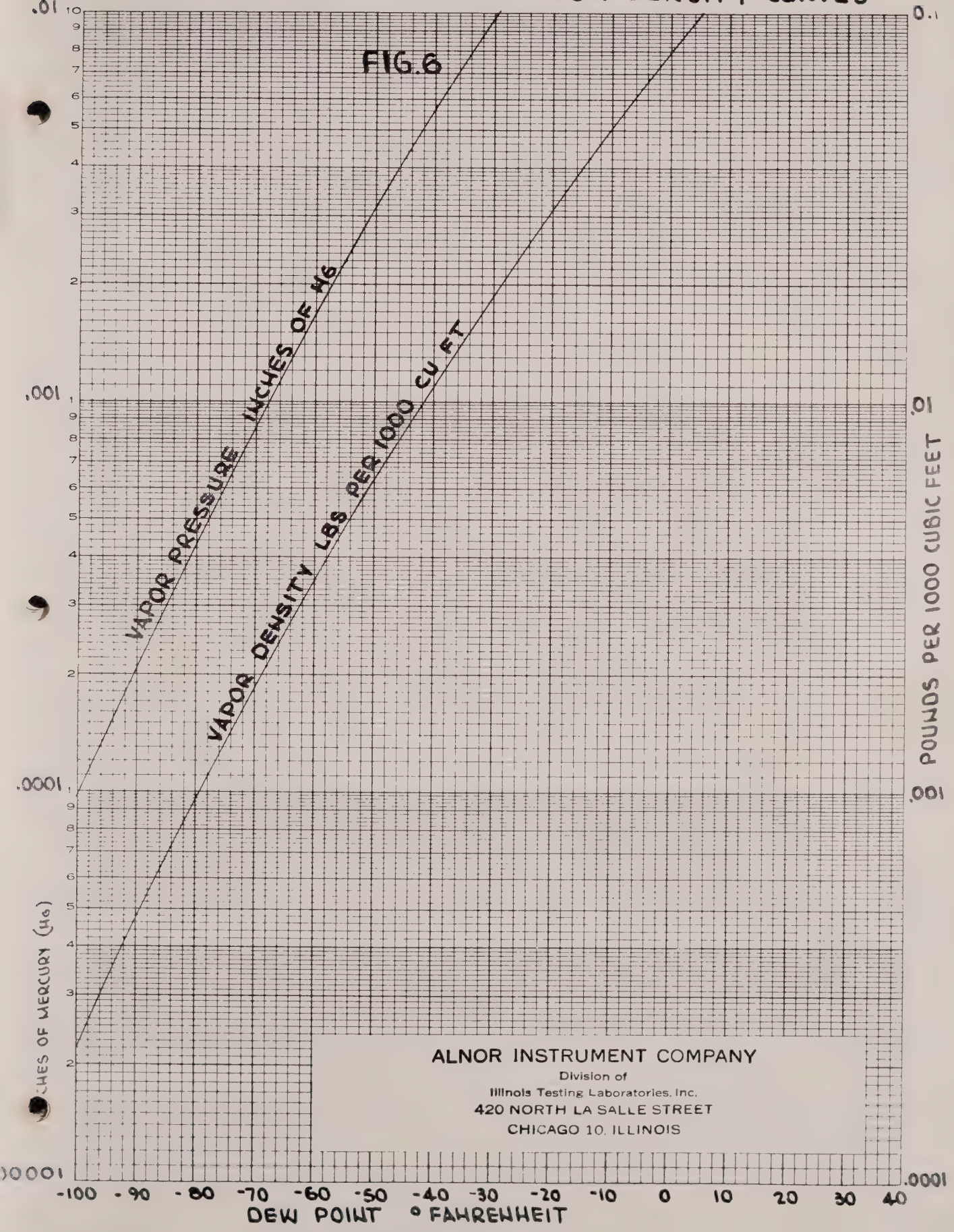
For each dew point there is a corresponding water vapor pressure and water vapor density. The "Alnor" Dew Pointer might just as well have been named a "Vapor Pressure Tester" or "Vapor Density Gauge". The following curves have been provided to permit easy transfer from one set of values to another as the need arises.

For dew points below freezing there are theoretically two possible values for vapor pressure, that is, vapor pressure over ice or vapor pressure over water. There is considerable experimental evidence indicating that the vapor pressure of air corresponds with the vapor pressure of sub-cooled water, whether the air is actually in contact with sub-cooled water or with ice. Accordingly the vapor pressures plotted on the following curves correspond with the vapor pressures over sub-cooled water. Vapor densities are plotted on the same basis.



VAPOR PRESSURE AND VAPOR DENSITY CURVES

FIG. 6



ALNOR INSTRUMENT COMPANY
Division of
Illinois Testing Laboratories, Inc.
420 NORTH LA SALLE STREET
CHICAGO 10, ILLINOIS

THE DEW POINTER AS A "GO, NO-GO GAUGE'

For shop use it is frequently desirable to use the Dew Pointer as a Go, No-Go Gauge. In this case the operation of the instrument becomes so simple that comparatively unskilled workmen can use it.

As an example assume a situation where a gas having a Q value of .2855 is carried in a pipe line at 1 pound gauge pressure. The process is to be operated so that the dew point is kept below 0° F. By performing the operations in reverse order the Dew Point Calculator can be used to develop a chart as follows:

1. Set the initial temperature opposite the critical Dew Point Temperature.
2. Opposite the arrow under (2) read the pressure ratio.

FOR 0° F. DEW POINT

Q .2855

Thermometer	Pressure Ratio Gauge
70	.61
72	.60
74	.59
76	.583
78	.577
80	.57

The instrument can be left connected to the gas line continously with the purge valve cracked so that a small amount of gas is bleeding thru continously. Thus no additional purging would be required. All the operator would have to do is read the thermometer - close the purging valve - pump the instrument up to the indicated pressure ratio - pause for fifteen seconds - and press the operating valve. If a fog appears the dew point is above 0° F.

DEW POINTS AT ELEVATED PRESSURES

If a sample of gas is compressed it is apparent the vapor pressure is increased. The compressed gas, therefore, has a higher dew point that corresponds to the new vapor pressure.

The "Alnor" Dew Pointer gives the dew point at atmospheric pressure. When the corresponding dew point at higher pressures is required refer to Figure 8.

Example: A gas is carried in a pipe line at 585 pound gauge pressure. The "Alnor" Dew Pointer indicates the dew point is -65° F. What is the actual dew point in the pipe line.

Answer is 1° F.

PSYCHROMETRIC CHART

Figure 9 shows the relationship between dew point temperatures, dry bulb temperatures, and relative humidity in the low humidity regions which are difficult to to read on the usual psychrometric chart. The "Alnor" Dew Pointer is particularly useful for making humidity measurements in this comparatively dry region.

Relative humidity is by definition the ratio of the actual vapor pressure of water vapor (the saturated vapor pressure at the dew point) in an air-vapor mixture to its saturated vapor pressure at the dry bulb temperature.

Relative humidity may also be defined as ratio of the weight of water vapor in one cubic foot of the mixture as indicated by its dew point, to the weight of water vapor in one cubic foot of a saturated mixture at the dry bulb temperature.

Example: Dry Bulb Temperature 80° F.
Dew Point Temperature 0° F.

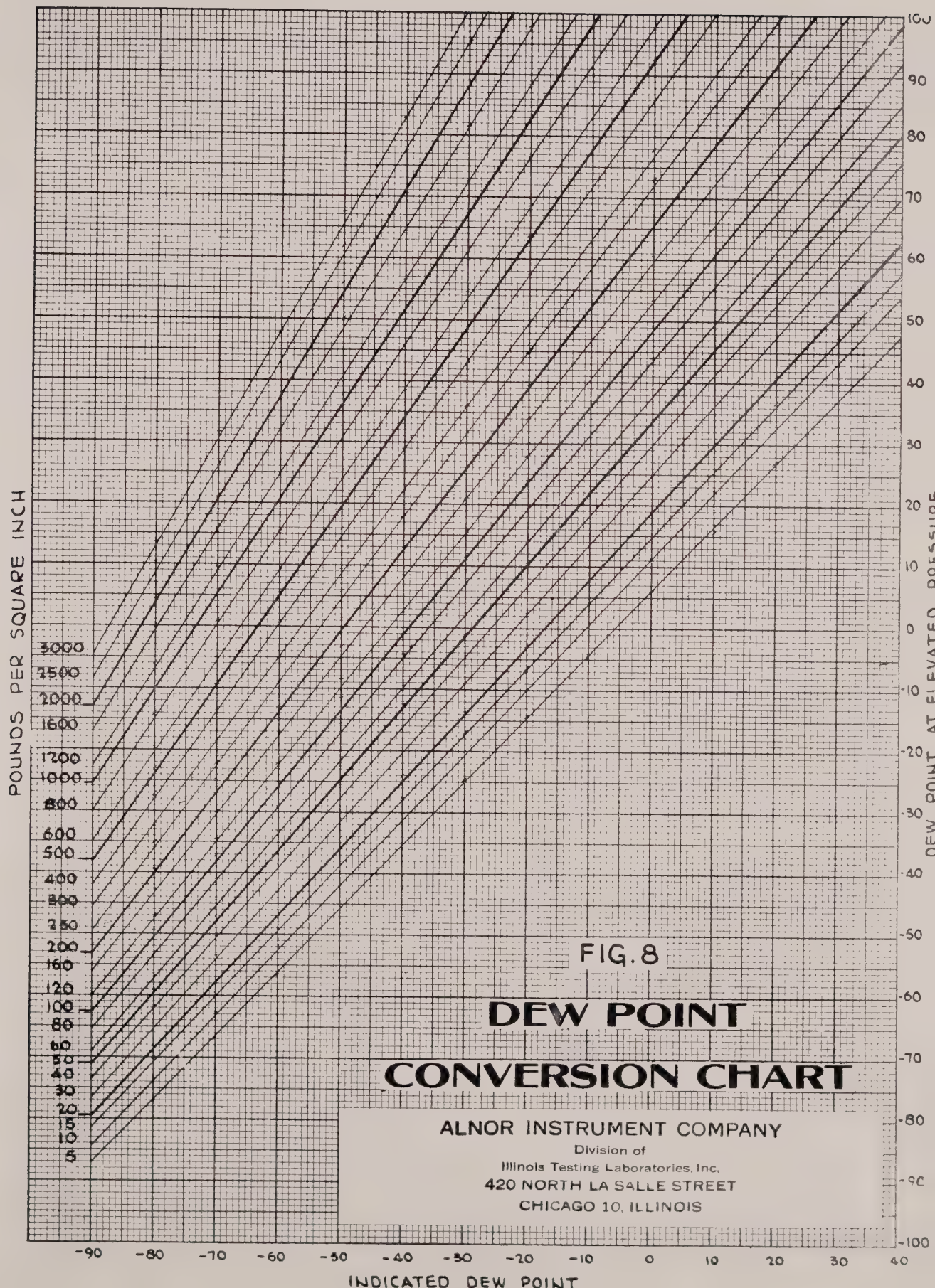
What is the Relative Humidity?
Answer from Figure 9 4.4%

Figure 10 is a standard Psychrometric Chart. In addition to dew point temperatures, dry bulb temperatures and relative humidity, it shows wet bulb temperatures, grains of water vapor per cubic foot, grains of water vapor per pound of dry air and the volume of the mixture in cubic feet of mixture per pound of dry air.

Example: Dry Bulb Temperature 90° F.
Dew Point Temperature 50° F.

What other values can be read from the Psychrometric Chart?

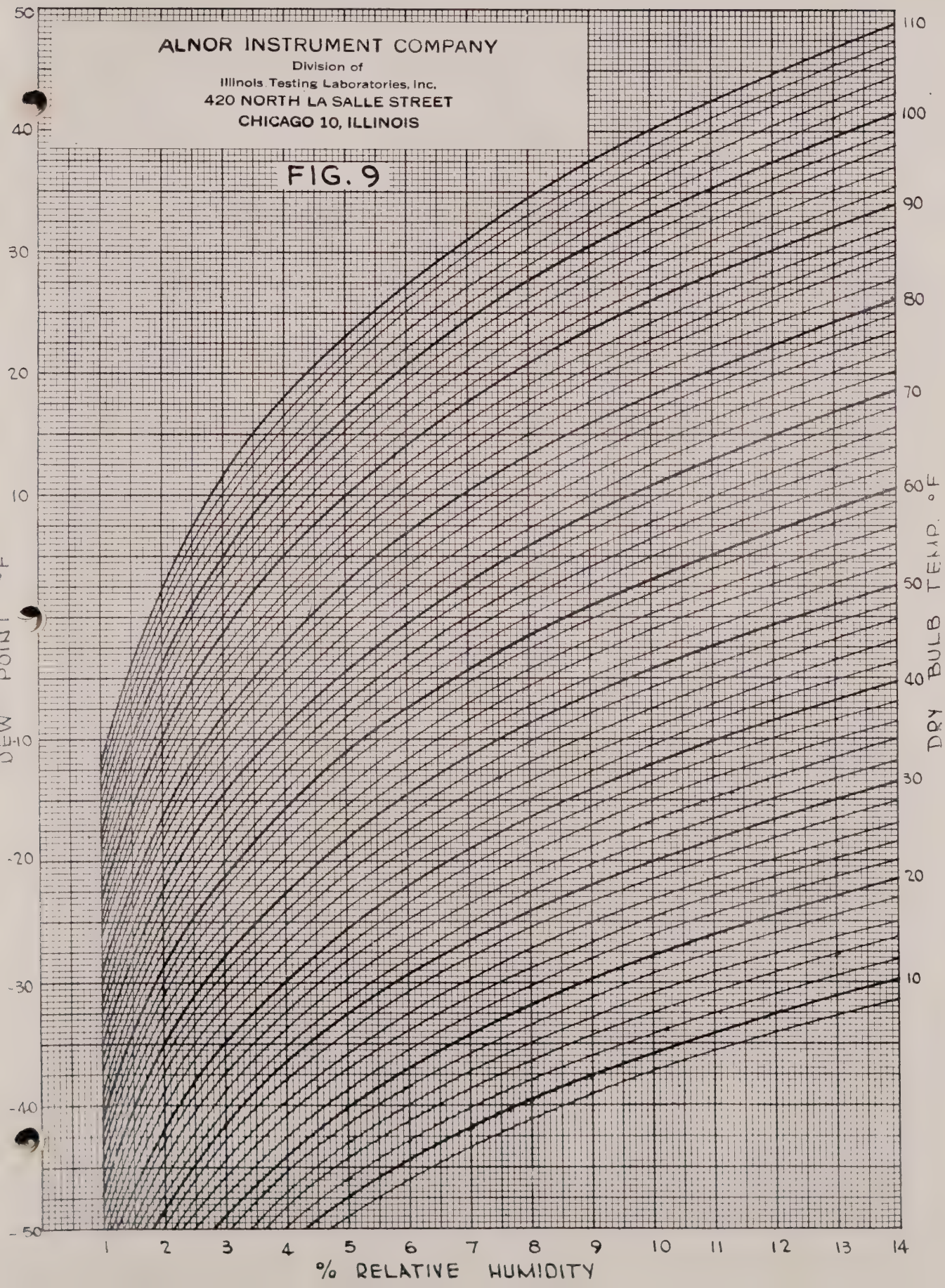
Answer: Wet Bulb Temperature 65° F.
Relative Humidity 25%.
Volume of the Mixture 14.0 per cu. ft. of dry air.
Density of the vapor 4.11 grains per cu. ft.
Weight of the vapor 53.4 grains per lb. of dry air.


POUNDS PER SQUARE INCH
3000
2500
2000
1600
1200
1000
800
600
500
400
300
250
200
160
120
100
80
60
50
40
30
20
15
10
5
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40
INDICATED DEW POINT
100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100
DEW POINT AT ELEVATED PRESSURE
FIG. 8
DEW POINT
CONVERSION CHART
ALNOR INSTRUMENT COMPANY
Division of
Illinois Testing Laboratories, Inc.
420 NORTH LA SALLE STREET
CHICAGO 10, ILLINOIS

PSYCHROMETRIC CHART

ALNOR INSTRUMENT COMPANY
Division of
Illinois Testing Laboratories, Inc.
420 NORTH LA SALLE STREET
CHICAGO 10, ILLINOIS

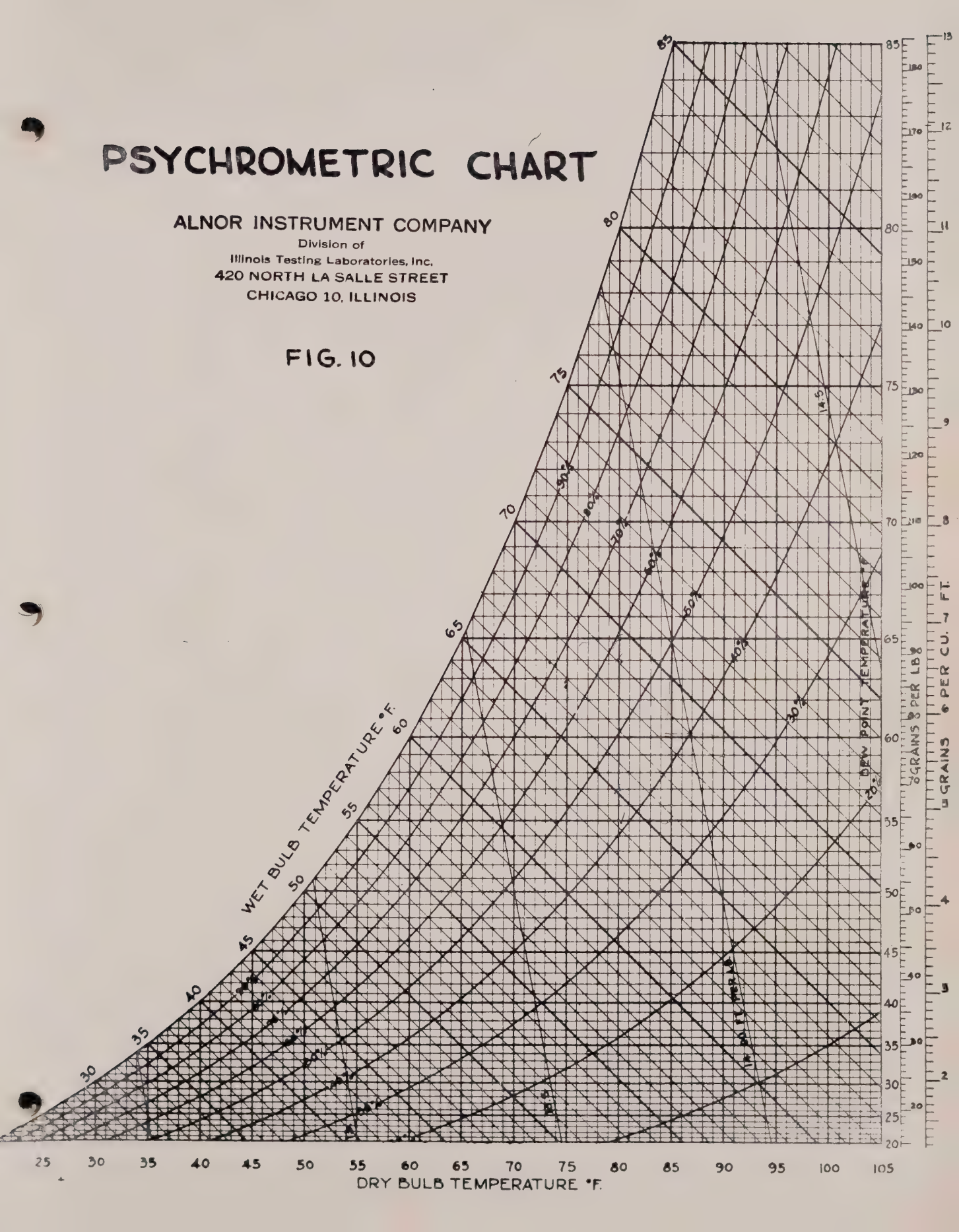
FIG. 9



PSYCHROMETRIC CHART

ALNOR INSTRUMENT COMPANY
Division of
Illinois Testing Laboratories, Inc.
420 NORTH LA SALLE STREET
CHICAGO 10, ILLINOIS

FIG. 10


WET BULB TEMPERATURE °F.
DRY BULB TEMPERATURE °F.
GRAINS OF MOISTURE PER LB. OF DRY AIR
GRAINS PER CU. FT.
DEW POINT TEMPERATURE °F.
RELATIVE HUMIDITY
ENTHALPY
25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105
30 35 40 45 50 55 60 65 70 75 80 85
20 25 30 35 40 45 50 55 60 65 70 75 80 85
2 3 4 5 6 7 8 9 10 11 12 13

TEMPERATURE CONVERSION TABLE

°C		°F	°C		°F	°C		°F	°C		°F
-73.3	-100	-148	-45.6	-50	-58.0	-17.8	0	32.0	10.0	50	122.0
-72.8	-99	-146.2	-45.0	-49	-56.2	-17.2	1	33.8	10.6	51	123.8
-72.2	-98	-144.4	-44.4	-48	-54.4	-16.7	2	35.6	11.1	52	125.6
-71.7	-97	-142.6	-43.9	-47	-52.6	-16.1	3	37.4	11.7	53	127.4
-71.1	-96	-140.8	-43.3	-46	-50.8	-15.6	4	39.2	12.2	54	129.2
-70.6	-95	-139.0	-42.8	-45	-49.0	-15.0	5	41.0	12.8	55	131.0
-70.0	-94	-137.2	-42.2	-44	-47.2	-14.4	6	42.8	13.3	56	132.8
-69.4	-93	-135.4	-41.7	-43	-45.4	-13.9	7	44.6	13.9	57	134.6
-68.9	-92	-133.6	-41.1	-42	-43.6	-13.3	8	46.4	14.4	58	136.4
-68.3	-91	-131.8	-40.6	-41	-41.8	-12.8	9	48.2	15.0	59	138.2
-67.8	-90	-130.0	-40	-40	-40	-12.2	10	50.0	15.6	60	140.0
-67.2	-89	-128.2	-39.4	-39	-38.2	-11.7	11	51.8	16.1	61	141.8
-66.7	-88	-126.4	-38.9	-38	-36.4	-11.1	12	53.6	16.7	62	143.6
-66.1	-87	-124.6	-38.3	-37	-34.6	-10.6	13	55.4	17.2	63	145.4
-65.6	-86	-122.8	-37.8	-36	-32.8	-10.0	14	57.2	17.8	64	147.2
-65.0	-85	-121.0	-37.2	-35	-31.0	-9.4	15	59.0	18.3	65	149.0
-64.4	-84	-119.2	-36.7	-34	-29.2	-8.9	16	60.8	18.9	66	150.8
-63.9	-83	-117.4	-36.1	-33	-27.4	-8.3	17	62.6	19.4	67	152.6
-63.3	-82	-115.6	-35.6	-32	-25.6	-7.8	18	64.4	20.0	68	154.4
-62.8	-81	-113.8	-35.0	-31	-23.8	-7.2	19	66.2	20.6	69	156.2
-62.2	-80	-112.0	-34.4	-30	-22.0	-6.7	20	68.0	21.1	70	158.0
-61.7	-79	-110.2	-33.9	-29	-20.2	-6.1	21	69.8	21.7	71	159.8
-61.1	-78	-108.4	-33.3	-28	-18.4	-5.6	22	71.6	22.2	72	161.6
-60.6	-77	-106.6	-32.8	-27	-16.6	-5.0	23	73.4	22.8	73	163.4
-60.0	-76	-104.8	-32.2	-26	-14.8	-4.4	24	75.2	23.3	74	165.2
-59.4	-75	-103.0	-31.7	-25	-13.0	-3.9	25	77.0	23.9	75	167.0
-58.9	-74	-101.2	-31.1	-24	-11.2	-3.3	26	78.8	24.4	76	168.8
-58.3	-73	-99.4	-30.6	-23	-9.4	-2.8	27	80.6	25.0	77	170.6
-57.8	-72	-97.6	-30.0	-22	-7.6	-2.2	28	82.4	25.6	78	172.4
-57.2	-71	-95.8	-29.4	-21	-5.8	-1.7	29	84.2	26.1	79	174.2
-56.7	-70	-94.0	-28.9	-20	-4.0	-1.1	30	86.0	26.7	80	176.0
-56.1	-69	-92.2	-28.3	-19	-2.2	-0.6	31	87.8	27.2	81	177.8
-55.6	-68	-90.4	-27.8	-18	-.4	0	32	89.6	27.8	82	179.6
-55.0	-67	-88.6	-27.2	-17	1.4	0.6	33	91.4	28.3	83	181.4
-54.4	-66	-86.8	-26.7	-16	3.2	1.1	34	93.2	28.9	84	183.2
-53.9	-65	-85.0	-26.1	-15	5.0	1.7	35	95.0	29.4	85	185.0
-53.3	-64	-83.2	-25.6	-14	6.8	2.2	36	96.8	30.0	86	186.8
-52.8	-63	-81.4	-25.0	-13	8.6	2.8	37	98.6	30.6	87	188.6
-52.2	-62	-79.6	-24.4	-12	10.4	3.3	38	100.4	31.1	88	190.4
-51.7	-61	-77.8	-23.9	-11	12.2	3.9	39	102.2	31.7	89	192.2
-51.1	-60	-76.0	-23.3	-10	14.0	4.4	40	104.0	32.2	90	194.0
-50.6	-59	-74.2	-22.8	-9	15.8	5.0	41	105.8	32.8	91	195.8
-50.0	-58	-72.4	-22.2	-8	17.6	5.6	42	107.6	33.3	92	197.6
-49.4	-57	-70.6	-21.7	-7	17.6	6.1	43	109.4	33.9	93	199.4
-48.9	-56	-68.8	-21.1	-6	21.2	6.7	44	111.2	34.4	94	201.2
-48.3	-55	-67.0	-20.6	-5	23.0	7.2	45	113.0	35.0	95	203.0
-47.8	-54	-66.2	-20.0	-4	24.8	7.8	46	114.8	35.6	96	204.8
-47.2	-53	-63.4	-19.4	-3	26.6	8.3	47	116.6	36.1	97	206.6
-46.7	-52	-61.6	-18.9	-2	28.4	8.9	48	118.4	36.7	98	208.4
-46.1	-51	-59.8	-18.3	-1	30.2	9.4	49	120.2	37.8	100	212.0

The legislatures of some of our states have passed bills to protect the people within their states from the indiscriminate use of radio-active materials. In general, these laws require that every piece of equipment containing any radio-active substance, however small, be marked with a distinctive symbol by the owner or user. (time pieces excepted)

Also some of the legislatures have required that each piece of equipment be registered with the State.

In order to facilitate the compliance with these laws in the states where they do exist, we are including the specified symbols in the form of decals and are providing the information which most of the present laws are requesting.

The amount of radio-active material in this instrument is so small that no hazard exists under any conceivable circumstances. This has been ascertained by certified radiological tests.

DATA

1 - Fixed source, sealed, containing 6-1/4 microcuries radium foil.

ALNOR INSTRUMENT COMPANY
DIV. OF ILLINOIS TESTING LABORATORIES, INC.
420 N. La Salle Street
Chicago 10, Illinois

MAINTENANCE AND SERVICE NOTES

FOR

"ALNOR" DEW POINTERS

To operate satisfactorily, the "Alnor" Dew Pointer must be kept clean and lubricated frequently.

1. **Filter** – Check the filter (fiber glass) frequently and replace the filter material when necessary. This is **very** important. Fiber glass is inexpensive – use it freely. Be sure filter-screen is in place.

2. **Lubrication** – Keep the pump piston lubricated with a good grade of white petroleum (Vaseline). **Do not over-lubricate.** When working with hydrogen the pump piston must be lubricated more frequently.

3. **Bubbles in oil column** – Bubbles in the oil column of the pressure ratio gauge can easily be removed by alternately pumping up the instrument and releasing the pressure. Tilt the instrument forward or to the left during this operation because this will help remove the bubbles.

4. **Refilling Oil Well** – If the oil is accidentally blown out through the gauge valve (see paragraph No. 9, Ratio Gauge) additional oil can be added.

    a. Be sure the purging valve is open, operating valve up (plunger pulled out) and there is no flow to the instrument.
    b. Remove the knurled knob on the filling well and unscrew the needle screw. Use a small screw-driver to fit the filling well.
    c. Place the unity adjuster in its mid position.
    d. Tilt the instrument to the left.
    e. Depress the gauge valve, **and at the same time** add oil by means of the eye dropper provided, until the column comes up to the 1.0 mark. Hold the dropper firmly in the filling well. Release the gauge valve before removing the dropper. Be sure that the needle screw is tightened in place before attempting to use the instrument.
    f. The manometer oil supplied has a specific gravity of .834. Any other grade oil having approximately the same specific gravity can be used because the density of the oil is not a major factor in the calibration of the Pressure Ratio Gauge.

5. **Leaks** – To operate satisfactorily, the "Alnor" Dew Pointer must be free from leaks.

    a. Check all connections. The purging valve can be reseated by tightening the needle point into the seat. Wear on the operating valve packing can be taken up by tightening the top cap. Check the fog chamber window and lens cap.
    b. If after checking all connections and parts, the oil column in the pressure ratio gauge still should drop, the fault may be in the double acting pump.

ALNOR INSTRUMENT COMPANY
DIV. OF ILLINOIS TESTING LABORATORIES, INC.
420 N. LaSalle Street
Chicago, Illinois 60610

6. Pump – The pump is designed so no outside atmospheric pressure can interfere with the pump action and only the gas to be tested will go through.
   a. The pump is provided with 4 valves (see fig. F). The inlet valve (from filter) and the outlet valve (to operating valve) are the main valves. If dirt or any other foreign particles accumulates in any one of these valves, the pump will not work properly.
   b. To check inlet valve (valve from filter) set oil column to 1.0 mark. Pump 10 full strokes and the oil column should come above .45 mark. If it takes more than 12 full strokes, the diaphragm could be damaged (stretched) or the inlet valve could be faulty. Loosen nut, carefully bend tubing to one side, unscrew valve screw, remove rubber seat, plunger and spring and clean all parts. If any of these parts are damaged, they should be replaced. Placing the parts back again, be sure to follow figure F. The valve screw should be tight.
   c. To check outlet valve (to operating valve) pump up the pressure to approximately .4 mark, observe the oil column, if there is a slow drop of the oil and after depressing the operating valve, even a faster drop, the fault will be in the outlet valve. Proceed in the same manner as on the inlet valve, when replacing the parts again, be sure to follow figure F.
   d. Keep the pump piston and "O" ring lubricated, and if necessary replace "O" ring.

7. Operating Valve – The operating valve generally requires little maintenance aside from occasional tightening of the top cap. If it is necessary to disassemble the valve be sure to follow figure C carefully when reassembling. Lubricate all parts with petroleum jelly before reassembling.

8. Fog Chamber – Keep window and lens clean. If necessary replace gaskets. Should the fog chamber become dirty and corroded, the instrument should be sent to the manufacturer for general cleaning, repair and recalibration.

9. Ratio Gauge – If the oil is accidentally blown out through the gauge valve, the gauge valve should be washed with naphtha or alcohol. Remove manometer push button by using wrench. To unscrew manometer valve, use two small screw drivers and remove valve. When replacing the valve be sure the "O" ring is in place. Leaks at the unity-adjuster can be corrected by replacing the two "O" rings or the complete adjuster. See figure E. Because of the high coefficient of expansion of the manometer oil frequent readjustment to the 1.0 mark is quite normal if the temperature is changing.

10. Reservoir – If diaphragm is damaged (usually stretched) the oil column in the pressure ratio gauge will not come up to the right pressure and excessive pumping becomes necessary and the correct Dew Point can not be obtained. The diaphragm is a Mylar Film. This material is very tough and it is most improbable that a rupture will occur. However depressing the gauge valve when the instrument is under pressure, may stretch the diaphragm. This may also result from pumping when the operating plunger is depressed. If this happens the diaphragm must be replaced. In most of these cases, the instrument should be sent back to the manufacturer for cleaning and repair.

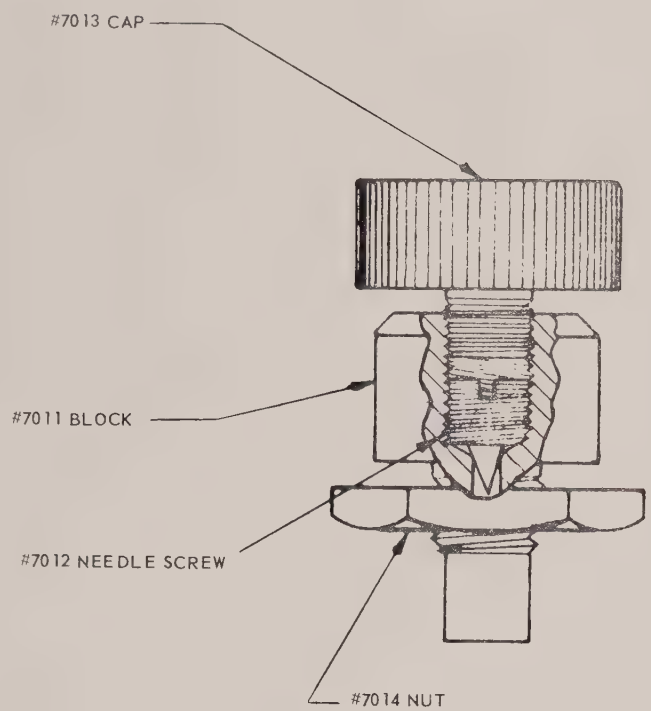
PARTIAL PARTS LIST FOR ALNOR DEW POINTER

(one each required unless otherwise noted)

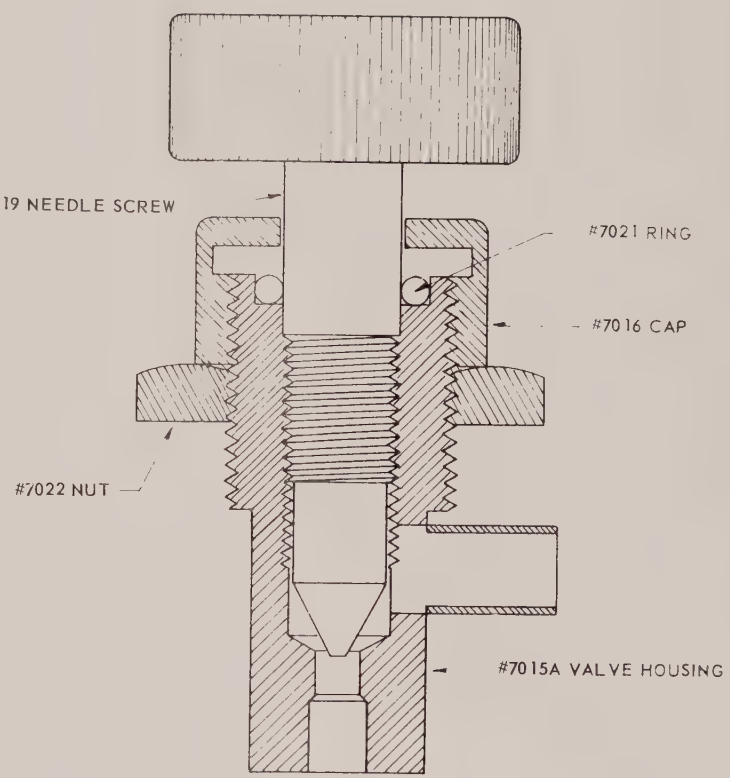
WHEN ORDERING PARTS PLEASE SPECIFY TYPE AND SERIAL NUMBER

PART NO.	DESCRIPTION	
7009	Inlet Fitting	
7010	Oil Refill Assembly See Fig. A	
7020	Purging Valve Assembly See Fig B	
	7040 OPERATING VALVE ASSEMBLY See Fig. C	
7039	Spacer	(2 required)
7041	Female V Ring	(4 required)
7042	Male V Ring	(4 required)
7043	Hydraulic V Ring	(8 required)
7044	Spring Washer	(2 required)
7045	Felt Washer	(2 required)
	7060A FOG CHAMBER Serial No. 3850 and Higher See Fig. D	
7057A	Fog Chamber Gasket (4 required) Gasket for Serial No. 3849 and Lower	
7057	Fog Chamber Gasket Top	(2 required)
7058	Fog Chamber Gasket Bottom	(2 required)
	7065 RATIO GUAGE See Fig. E	
7068	"O" Ring	(3 required)
7070	Unity Adjuster Assembly	
7078	Guage Valve Assembly	
7084	Pushbutton Assembly	
	RESERVOIR	
7099	Diaphragm	
	FILTER	
7104	Filter Cap	
7105	Filter Gasket	
7106	Filter Screen	
	7150 PUMP See Fig. F	
7120	Recommended Spare Parts Group Includes:	
	3 No. 7117 Check Valve Screws	(3 required)
	1 No. 7117A Check Valve Screw	
	12 No. 7118 Check Valve Plunger	(4 required)
	12 No. 7119 Check Valve Seat	(4 required)
	12 No. 7121 Check Valve Spring	(4 required)
	6 No. 7127 Piston "O" Ring	
7124	Piston Rod Assembly	
7138	Pump Cap Assembly	
	OTHER PARTS	
7151	Thermometer Shield	
7152	Thermometer Base	

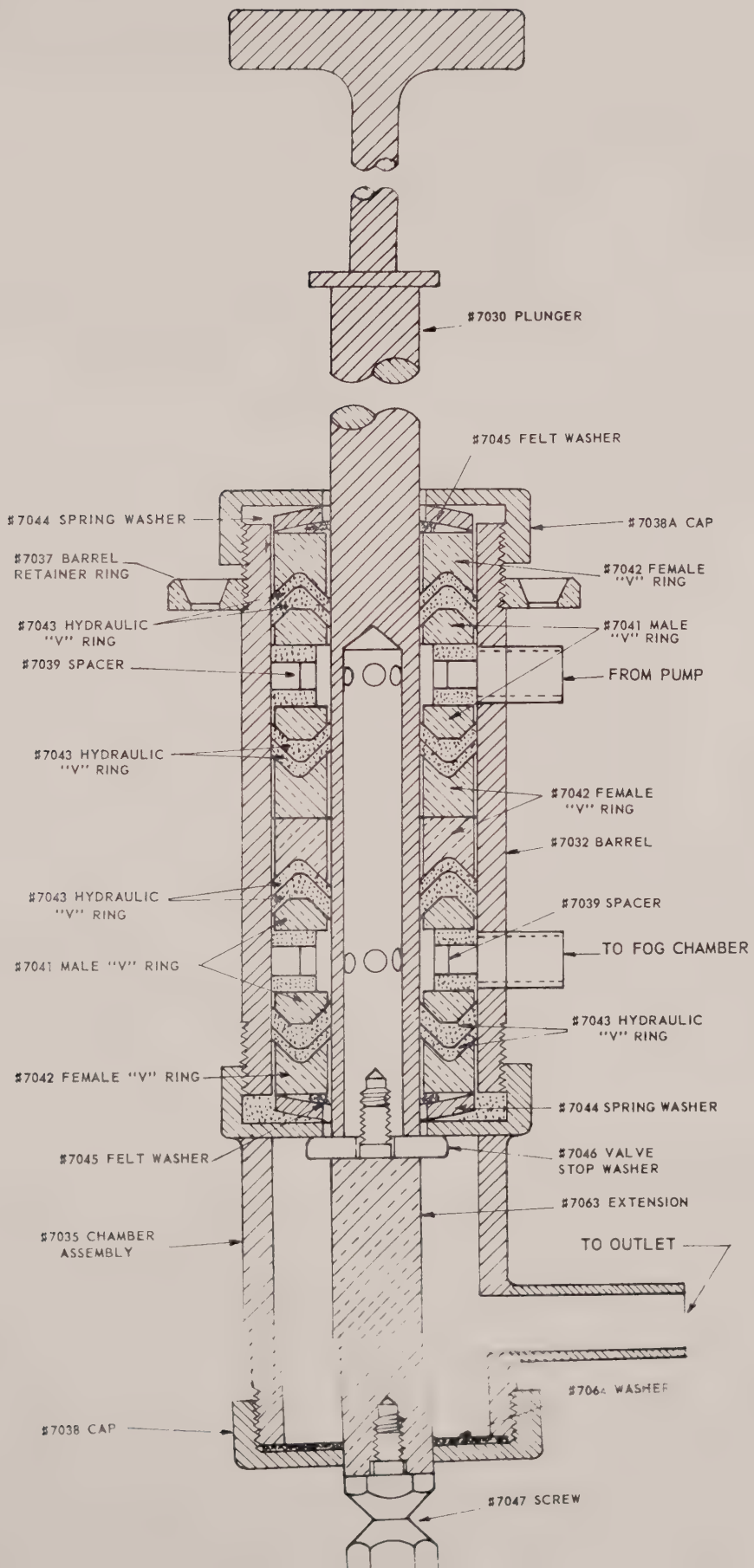
PART NO.	DESCRIPTION
7153	Thermometer Protection Tube
7154	Thermometer 40° to 120° F.
7192	Hose Nipple Connector
7193	Tubing Nipple Connector
7219	Plastic Tubing
7229	Wrench
7230	Calculator
7231	Manometer Oil
7235	Filter Fiber Glass
7240	Dew Pointer Instruction
7240A	Maintenance Instruction
	ELECTRICAL SYSTEM
7176	S.P.S.T. Toggle Switch
7177	D.P.D.T. Toggle Switch
7190	Mercury Switch Assembly
7205	Lamp Socket
7206	Lamp 6-8 Volts
7210	Transformer
7211	Battery 7.5 Volts
7212	Battery Male Plug
7220	Cable Assembly
	FOR TYPE 7200 AND 7350 ONLY
	7261 RUPTURE FITTING See Fig. G
7258	Rupture Cap
7259	Rupture Gasket
7260	Rupture Disc
	7266 INLET VALVE See Fig. H
7021	"O" Ring
7265	Needle Screw
	7270 AUTOMATIC RELIEF VALVE See Fig. I
7117A	Check Valve Screw
7075	Check Valve Spring
7118	Check Valve Plunger
7119	Check Valve Seat
	FOR TYPE 7300 AND 7350 ONLY
7307	Rheostat
7309	Push Button Switch
7310	Resistance Thermometer
7320	Ratio Guide Assembly Complete
7325	Pump Assembly Complete (For Type 7300 Only)



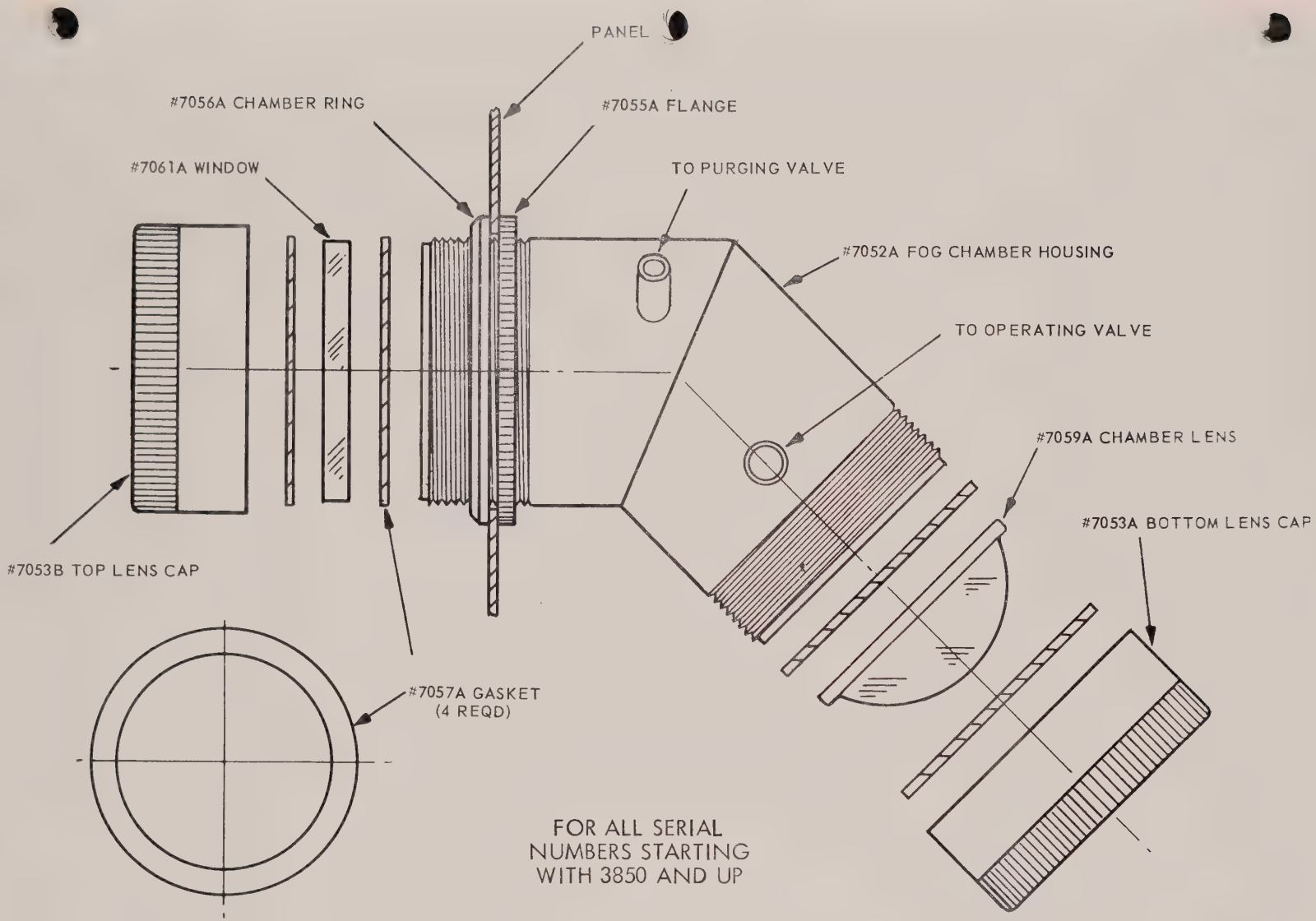
OIL REFILL ASSEMBLY #7010
FIG. A



PURGING VALVE ASSEMBLY #7020
FIG. B

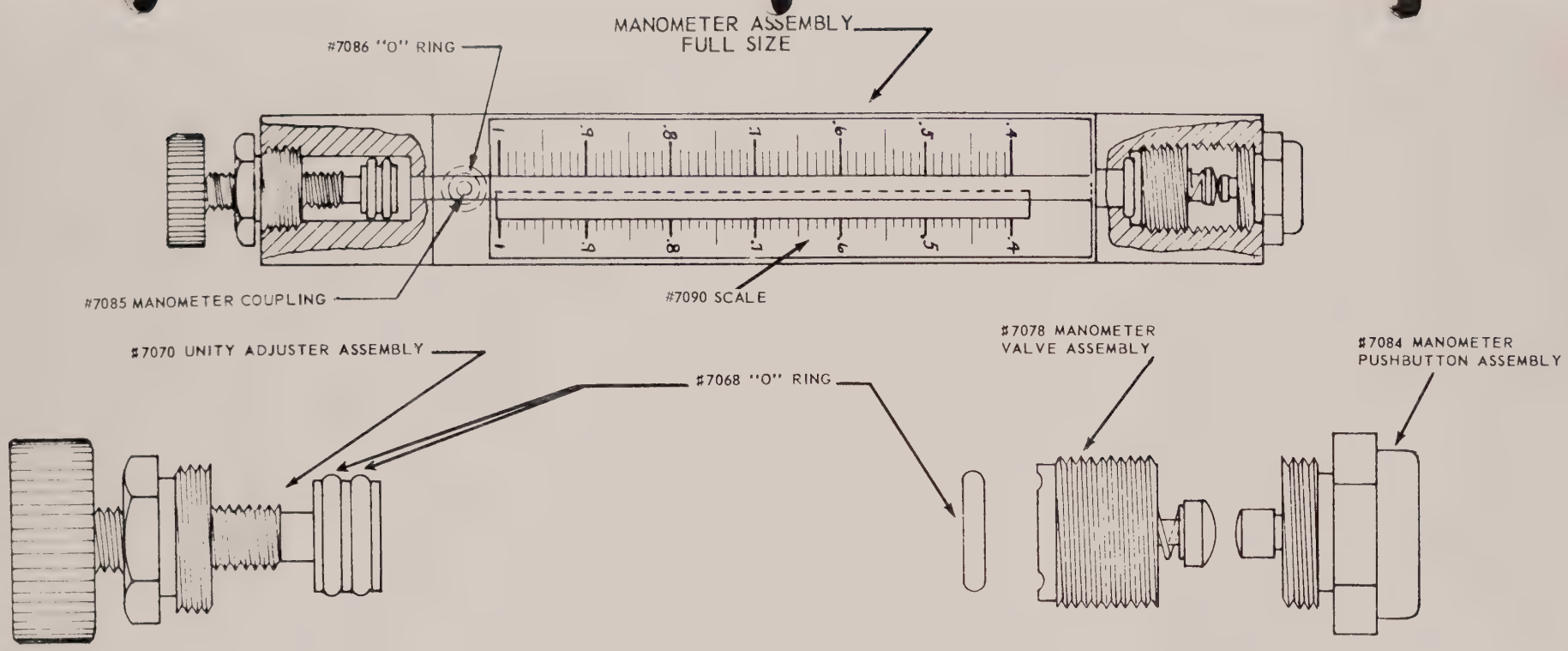


OPERATING VALVE ASSEMBLY #7040
(when ordering, specify type & serial no.)
FIG. C

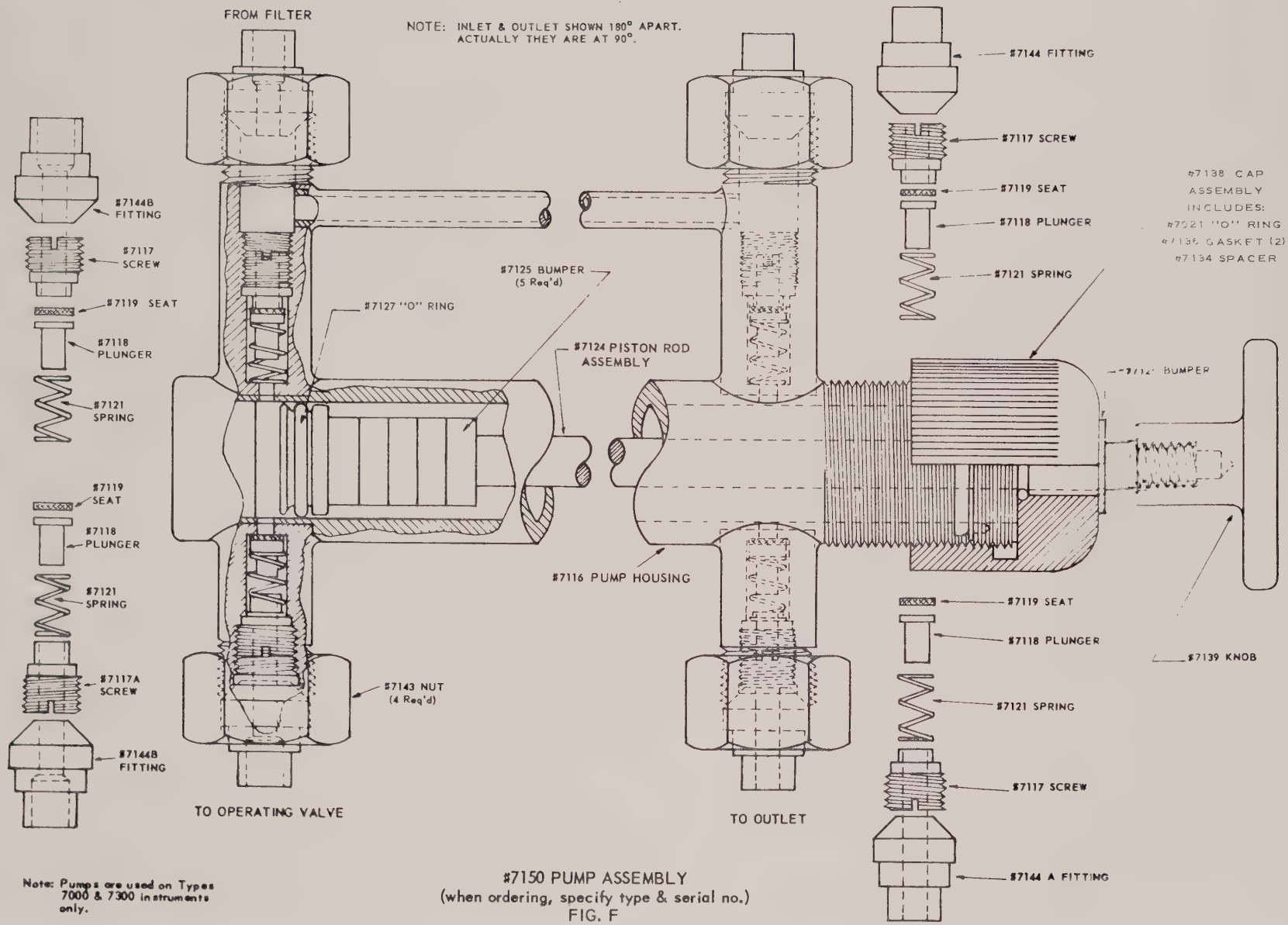


FOG CHAMBER ASSEMBLY #7060A
(when ordering, specify type & serial no.)
FIG. D

NOTICE: FIG. D-1
APPLIES WHEN
SERIAL # IS 3850
OR HIGHER



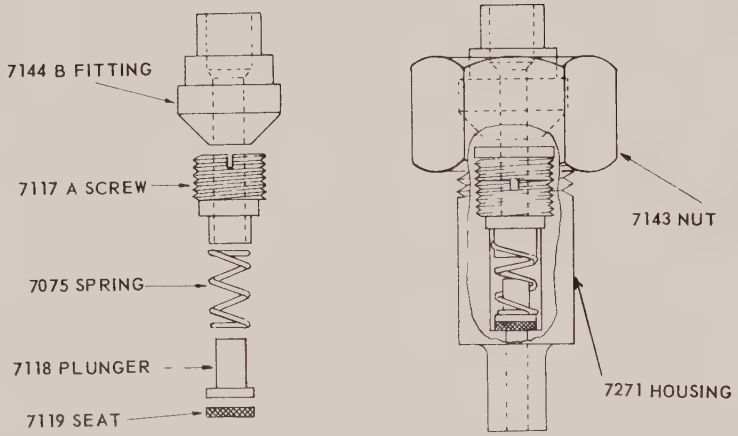
#7065 RATIO GUAGE ASSEMBLY
(when ordering, specify type & serial no. - h, u, or l)
DOUBLE SIZE
FIG. E



Note: Pumps are used on Types 7000 & 7300 instruments only.

#7150 PUMP ASSEMBLY
(when ordering, specify type & serial no.)
FIG. F

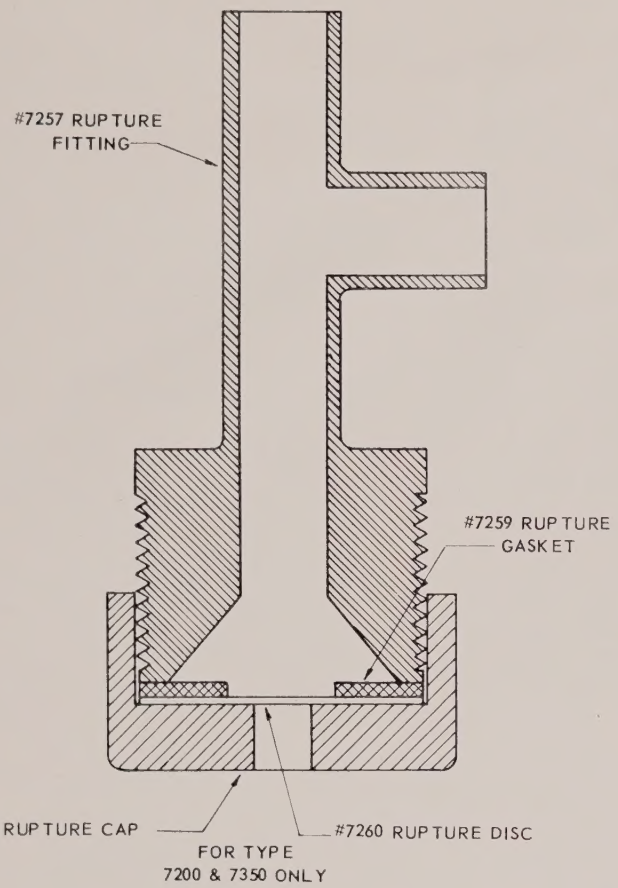
FIG. I



7270 AUTOMATIC RELIEF VALVE

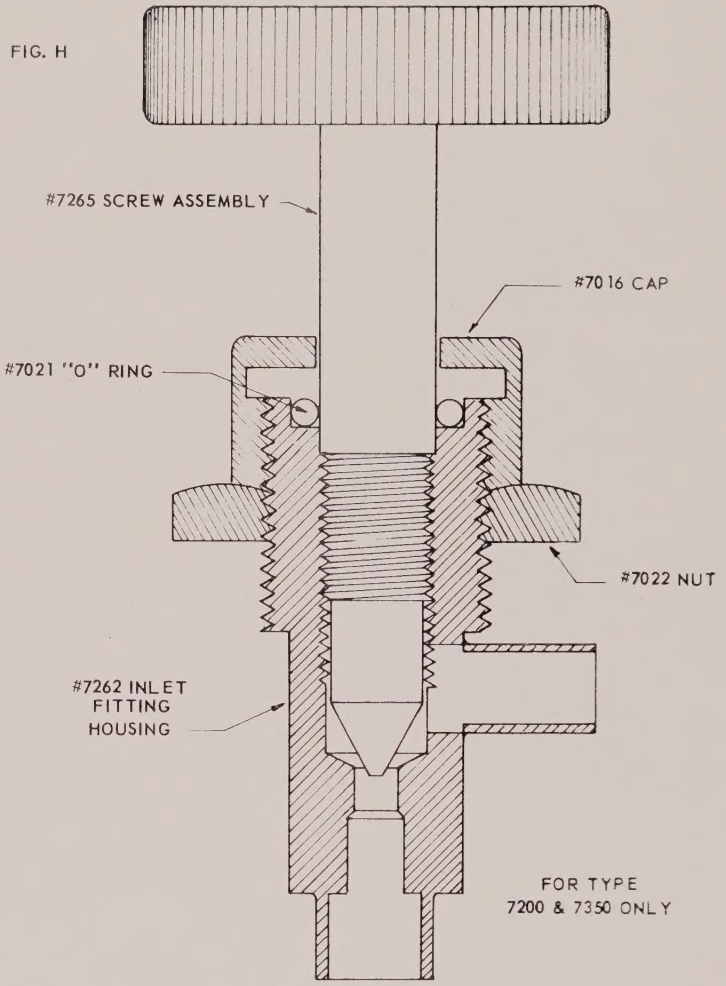
FOR TYPE 7200 & 7350 ONLY

FIG. G
#7261 RUPTURE FITTING ASSEMBLY



#7266 INLET VALVE ASSEMBLY

FIG. H



TROUBLE SHOOTING CHART

FOR

"ALNOR" DEW POINTER

OBSERVED DEFECT	PROBABLE FAULT	REMEDY
Oil drops in Pressure Ratio Gauge while under steady pressure	Leaks in system or Leak in pump outlet valve	See Paragraph 5 See Paragraph 6c
Oil rises in Pressure Ratio Gauge while under steady pressure	Leak in Pressure Ratio Gauge Valve	Replace Pressure Ratio Gauge Valve
Pump does not operate freely	Lack of Lubrication	Lubricate pump piston See Paragraph 2
Excessive pumping required	Restriction in supply to Dew Pointer or Diaphragm damaged	Remove Restriction See Paragraph 10
Oil must be replaced frequently	Leak at Unity adjuster	Replace "O" Rings on Unity Adjuster See Paragraph 9

Replace Filter Material Frequently.

100418